Sidestone Press, pp. 193-201. https://www.oxbowbooks.com/oxbow/seasonal-settlement-in-the-medieval-and-early-modern-countryside-67232.html

<h1>Too much environment and not enough history: the opportunities and challenges in researching medieval seasonal settlement in Atlantic Europe
<h1>Trop d'environnement et pas assez d'histoire: les opportunités et les défis de la recherche des établissements saisonniers médiévaux en Europe atlantique
<h1>Zu viel Umwelt und zu wenig Geschichte: die Chancen und Herausforderungen bei der Erforschung der mittelalterlichen saisonalen Besiedlung im westlichen Europa

<author>Richard Oram
Pathfoot Building
University of Stirling
Stirling FK9 4LA Scotland
United Kingdom
r.d.oram@stir.ac.uk

<h2>Abstract
Over the last twenty-five years, advances in palaeoenvironmental research have revolutionised our understanding of the physical effects of historic climate change around the North Atlantic rim across the eras of the Medieval Climate Anomaly and subsequent ‘little ice age’. This revolution has been marked in respect of marginal upland and coastal zones, where landscape-scale palaeoecological research coupled with excavation at abandoned perennial and seasonal settlement sites has provided high-quality and subtly nuanced data to evidence baseline conditions, impacts and responses. In Scotland, analysis of this data has been framed largely in terms of system sustainability and environmental resilience but, with few notable exceptions, has offered no examination of human agency in shaping responses to climate change or of wider historical contexts for trends evident in the palaeoenvironmental data. Equally, however, too few archaeologists and historians have engaged with the environmental contexts for socio-economic discontinuities, site abandonment and resource-related conflict reflected in artefact and ecofact assemblages or the parchment record. Consilience and inter/transdisciplinary approaches to the study of historic seasonal settlement and associated exploitation regimes can provide insights on human ecodynamic processes, avoiding the risk of unconscious determinism through linear, single discipline analyses and revealing the complex interplay of natural agency and human cultural responses to the opportunities and threats presented by past climate change.

<keywords>Keywords: Climate change, land management, upland exploitation, carrying capacity.

<h2>Résumé

Au cours des vingt-cinq dernières années, les progrès de la recherche paléoenvironnementale ont révolutionné notre compréhension des effets physiques du changement climatique historique autour du pourtour de l'Atlantique Nord à travers les périodes de l'anomalie climatique médiévale et du «petit âge glaciaire» qui a suivi. Ces chagements sont décrits pour les hautes terres marginales et les zones côtières, où la recherche paléoécologique à l'échelle du paysage couplée à des fouilles sur des sites de peuplement pérennes et saisonniers abandonnés a fourni des données de haute qualité et subtilement nuancées pour prouver les conditions de base, les impacts et les réponses. En Écosse, l'analyse de ces données a été conçue en grande partie en termes de durabilité du système et de résilience environnementale, mais, à quelques exceptions notables près, n'a proposé aucun examen de l'action humaine dans l'élaboration des réponses au changement climatique ou dans contextes historiques plus larges pour aux tendances évidentes des données paléoenvironnementales. De même, trop peu d'archéologues et d'historiens se sont penchés sur les contextes environnementaux pour expliquer les discontinuités socio-économiques, l'abandon de sites et les conflits liés aux ressources reflétés dans les assemblages d'artefacts et d'écofacts ou les registres de parchemins. La cohérence et les approches interdisciplinaires et transdisciplinaires de l'étude des établissements saisonniers historiques et des régimes d'exploitation associés peuvent fournir des informations sur les processus écodynamiques humains, en évitant le risque de déterminisme inconscient généré par des analyses linéaires et disciplinaires uniques et en révélant l'interaction complexe de l'action naturelle et des réponses culturelles humaines aux opportunités et auxmenaces présentées par les changements climatiques passés.
<keywords>Mots-clés: Changement climatique, gestion des terres, exploitation des hautes terres, capacité d’absorption.

<h2>Zusammenfassung

In den letzten 25 Jahren haben Fortschritte in der Paläoumweltforschung unser Verständnis bzgl. der Auswirkungen des historischen Klimawandels am europäischen Nordatlantikrand in den Epochen der mittelalterlichen Klimaanomalie und der anschließenden „kleinen Eiszeit“ revolutioniert. Diese Entwicklung wurde in Bezug auf marginale Hochland- und Küstengebiete beschrieben, in denen paläoökologische Untersuchungen in der Region in

Verbindung mit Ausgrabungen an verlassenen permanenten und saisonalen Siedlungsstandorten qualitativ hochwertige und subtil nuancierte Daten lieferten, um die Ausgangsbedingungen, Auswirkungen und Folgen nachzuweisen. In Schottland wurde die Analyse dieser Daten weitgehend im Hinblick auf die Nachhaltigkeit des Systems und die Widerstandsfähigkeit der Umwelt durchgeführt. Aber mit wenigen bemerkenswerten Ausnahmen wurde keine Untersuchung der menschlichen Handlungsfähigkeit bei der Gestaltung von Reaktionen auf den Klimawandel oder eines breiteren historischen Kontextes auf Trends in der Paläoumwelt durchgeführt. Gleichermaßen haben sich jedoch zu wenige Archäologinnen, Archäologen, Historikerinnen und Historiker mit den Umweltkontexten für sozioökonomische Diskontinuitäten, Standortverlassenheit und ressourcenbezogene Konflikte befasst, die sich in Artefakt- und Ökofakt-Assemblagen oder in schriftlichen Aufzeichnungen widerspiegeln. Konsilienz und inter- / transdisziplinäre Ansätze zur Untersuchung der historischen saisonalen Besiedlung und der damit verbundenen Ausbeutungsregime können Einblicke in die ökodynamischen Prozesse des Menschen geben, das Risiko eines unbewussten Determinismus durch lineare Analysen einzelner Disziplinen vermeiden und das komplexe Zusammenspiel von natürlicher Handlungsfähigkeit und menschlichen kulturellen Reaktionen auf die Chancen und Risiken des vergangenen Klimawandels aufzeigen.

<keywords>Schlagwörter: Klimawandel, Landbewirtschaftung, Hochlandnutzung, Tragfähigkeit.

<h2>Introduction

Amongst high-level responses to the current ‘Climate Emergency’ is a growing discourse within environmental activist and scientific communities about what practices and behaviours humanity globally will have to stop or change to survive. With the 2010s now confirmed instrumentally as the hottest decade on record (*Beament 2020*) and against a backdrop of extreme weather events, bushfires, forest die-back and collapse in biodiversity and species resilience, discussion is moving towards change at a societal level and focussing on topics such as food-production/dietary staples, energy production and consumption, water security and transport, both short-range local commuting and international long-haul. Each area affects matters of cultural significance, some of profound importance for religious or philosophical reasons, but all touching on themes of identity at every level from the personal to the pan-societal. Global reporting, 24-hour worldwide news, multiple social media channels and the rise of open-access research has increased public awareness of climate

change, the debate over its causes, and the evidence of its impacts. Human – and animal – experience of climate change is visible and its effects on the environment in which we subsist are patent. Now, more than ever before, environmental history is offering insight on how climate change will affect modern culture and society, through the record of how our ancestors adapted and changed in the face of historic climate transitions. We are awash with readily accessible data on environmental impacts and can model outcomes, but most public debate is couched in terms of weather events. Where the effects of climate change on human populations are discussed, it is sea-level rise, salinizing of water-sources, or desertification in distant and usually under-developed countries that is highlighted. Rarely does the discourse turn to likely impacts on communities closer to home.

<h2>Climate change and historical discourse

Climate change research in the high Arctic, commencing in the later 20th century, has amassed abundant data for past episodes of climatic amelioration or deterioration. In respect of changes since the 9th century, it has had the informative side-effect of delivering detailed evidence for the impact of such episodes on the Norse Western Colonies along the North Atlantic arc from the Hebrides to Newfoundland. In contrast to the increasingly sophisticated interdisciplinary study of the impacts of medieval climate change on Greenlandic and Icelandic populations, however, there has been limited interdisciplinary exploration of the medieval Scottish experience. Engagement by historians of medieval rural culture and society in the northern British Isles – and Scotland especially – with analysis of environmental factors as motors for long term and large-scale social, economic and cultural change has been limited and, too often, quite superficial. There are important exceptions, mainly sharply focused local studies (*e.g. Brown et al. 1998*; *Tipping 1998*; *Tipping 2004* or *Dixon 2007*), but wider analyses over the long durée are lacking. Yet, this position is despite the daily reminders received by Scotland's people of the presence and impact of the dynamic weather that arises from its location at the north end of an island placed between the north-western European landmass and the Atlantic Ocean. Awareness of the major climatic episodes of the last millennium is reflected in generalised statements about Scotland's people maximising opportunities presented by early medieval climate optima (e.g. *Atkinson 2016*, 77), but more often it is the 'Golden Age' of the Medieval Climate Anomaly [MCA] that is alluded to. We are told that they pushed cultivation and pasture to the altitudinal and marginal maximum during these 'good times', but there is minimal reflection on what that expansion meant socially or culturally, or how climate change was experienced by those living at these

maxima when the good times ended. What increased or reduced opportunity meant in terms of social organisation and cohesion, cultural adaptability, community resilience, resource management, subsistence levels, production of dietary staples or levels of health and nutrition rarely features in the broad discussion. Cyclically, such limited engagement has disincentivised the adoption of the interdisciplinary methodologies that often are instruments for collection of environmental data from both documentary and archaeological sources, perpetuating a disjunction between historical and palaeoenvironmental research.

Where environmental historical research has been undertaken into Scottish lived experiences, however, it has shown the benefits of integrating environmental data to deliver a richer image of the opportunities and challenges presented by the rises and declines in climatic conditions. Such data from diverse written, climate proxy and instrumentally recorded sources illuminate the analysis of population responses in Scotland to the optimum climatic conditions of the MCA of the mid-11th to mid-13th centuries; the following era of deterioration into the 'little ice age', with its oscillation between sustained periods of profound climatic variability and relative stability against a generally downward trajectory in annual mean temperatures and upward trend in storminess from the mid-13th to mid-19th centuries; culminating in the modern era of rising temperatures globally and greater weather volatility. The present author and colleagues have applied these techniques to examination of social, economic and political outcomes from the MCA's decline from the 1250s to the 15th century (*Oram 2014a*; *Oram 2014b*; *Oram 2014c*; *Oram – Adderley 2008; Oram – Adderley 2010*). Those studies, however, offered headline overviews that argue for recontextualising of the well-rehearsed narratives of political reconfiguration and socio-economic realignment that have characterized Scottish historical discourse. The effects of climate change on key elements of the socio-economic landscape, such as seasonal upland exploitation regimes, requires more focussed research at a whole systems level.

Scottish historiography has traditionally taken political events, especially the death of kings, as transitional points in the nation's development. King Alexander III's death in 1286 is the arch-exemplar, viewed as the end of the kingdom's medieval 'Golden Age'. The sixty-year struggle for an independent national identity that followed his demise dominates all narratives, despite increasing awareness of the mythologising of which it is part. It was for long portrayed as precursor to an era of weak monarchy, 'over-mighty' nobles, and widespread social disturbance, epitomised by plundering raids launched from the Highlands against lowland districts, and noble factionalism and feuding. That portrayal, too, is now recognised as largely an historiographical fiction which cast the centralising tendencies of the

crown and the resistance to that of the magnate class in terms of a struggle between opposites of stability and chaos. Political narratives thus have dominated discourse in late medieval Scottish history, and the context for these trends expressed almost exclusively in terms of social disintegration and rising levels of violence, legal and illegal, consequent upon a failure of political leadership. Whilst the detail of that narrative has been serially challenged in recent years, the primary focus remains on socio-political contexts for change, including those visible in the archaeological record; the emphasis has shifted slightly to accommodate economic factors, but the driving themes still centre largely on high-level political conflict.

<h2>Towards a new environmental history

More recently, as data relating to millennial scale climatic trends in the northern hemisphere, and especially to the atmospheric and oceanic motors which powered them, has become available, a new historiography has emerged. This new prescription has begun to contextualise the well-recognised social, economic and political trends in a wider environmental frame. For example, Alasdair Ross viewed the probably 8th- to mid-9th-century establishment in northern Scotland of socio-economic units known as *daibhachean* (singular *dabhach*), organised to provide communities with pro rata access to adequate supplies of arable, lowland and upland grazing, water, building materials and fuel resources, and sustain those communities as the basis for military levies, as occurring in the context of a response by Pictish kings to Viking incursions (*Ross 2015*, 195-196). Although he provided a political explanation for the creation of the *daibhachean*, he understood their organisation in terms of human economic need and responsiveness to climatic opportunity, environmental constraints, and resource distribution. His methodology eschewed environmental determinism but offered climate-driven environmental change as just one vector, alongside the traditional historiographical media of political and economic disruption, for the introduction of unprecedented levels of opportunity or stress into the subsistence regimes upon which the Scottish peasant population depended and upon which long-established lordship structures were sustained. These opportunities and stresses provide context for cycles of growth and contraction, as argued for expansion of upland exploitation in the late Pictish period and its decline in the 11th century, re-expansion in the 12th century and collapse in the 14th (*Strachan et al. 2019*; *Oram 2014a*). In short, in the benign conditions of the third quarter of the 1st millennium AD and again in the MCA, as it got warmer, upland settlement, perennial and seasonal, expanded as population grew and lordship structures crystallised, but when it got colder and wetter in the later 10th century and again post-1250, biomass production

contracted, carrying capacity declined and upland regimes suffered. It was not, however, simply a matter of 'it got colder and wetter, and first livestock then people died', for we can see evidence for a wide range of human responses from increasing violence arising from competition over access to now-scarcer resources, changes to stocking levels or shifts towards livestock and cereal crop types better-adapted to harsher conditions, abandonment of the most marginal areas of settlement and agriculture, and the imposition of new organisational frameworks and administrative mechanisms to exploit more rigorously the labour of the peasant population. Responsive to both climatic factors and social pressures, Scotland's political elites who had creamed the surplus from upland regimes looked for new means to obtain the incomes upon which their status was founded, while peasant populations adapted to find a sustainable regime upon which to subsist; the social and political tensions evident in the historical record reflected human responses to these changed environmental circumstances and the impulsion to find a new *status quo* that delivered greater economic security and stronger social resilience.

Focussing just on the MCA to 'little ice age' transition, despite the fragmentary nature of the documentary record for much of the later 13th and 14th centuries, it is possible to construct an alternative broad-brush narrative for the era, summarised here. The Alexandrian 'Golden Age' is now better understood both as a cultural construction of later medieval Scottish nationalistic historiography and in the context of the climatic volatility of the declining decades of the MCA. That decline brought episodes of extreme weather – drought alternating with deluge, high summer temperatures counterpoised with extreme winter lows – and a generally downward trend in mean annual temperatures. References to headline extreme events - storms, coastal inundations, spate-floods, severe frosts, blizzards, crop failures and epizootic disease – and to their impacts on the human population, punctuate contemporary accounts. Summer and winter pasture and upland livestock regimes seem to have fared badly. A brief respite in the early 1300s led into the horrors of the 1315–1327 period; the Great European Famine and a pan-European cattle epizootic in a saturated decade of unprecedented rainfall for the eastern Atlantic rim (*Slavin 2010*; *Slavin 2019*; *Oram 2014a*). Scottish record evidence for this period is scant but the surviving records from adjacent regions of England and Ireland offer proxies that leave little doubt as to the likely impacts on Scotland.

Although the 1330s and 1340s saw greater stability in weather patterns, a downward trend in mean temperatures continued into mid-century, with the coldest years coinciding with the first pandemic of the Black Death. A recovery in temperatures through the 1370s led to an economic recovery reflected in records of bumper wool yields, but greater climatic volatility

in the last quarter of the century, reaching a peak in the early 1400s, ended that boom and stimulated competition for control of resources. A downward climatic trajectory thereafter became entrenched throughout the second and third quarters of the 15th century and the attendant economic precariousness, coupled with recurrent epidemic and epizootic outbreaks, contributed to widespread and protracted political volatility (*Oram 2014c*; *Oram – Adderley 2008*; *Oram – Adderley 2010*; *Tipping 2004*).

<h2>Climate proxy data

While this narrative can be nuanced by deductive reasoning and extrapolation of primarily qualitative data from the documentary record, the nature of the surviving Scottish records hinders reconstruction of the long runs of interrogable quantitative data necessary to model the impacts of climate change and pathogens at regional or local level. No amount of lamenting the absence of the type of manorial accounts that have enabled English environmental historians to express in human terms the consequences of the climatic slide from the highs of the MCA into the lows of the 'little ice age' can alter the fact that equivalent materials are irrecoverable for Scotland before the 1500s. We can, however, continue to broaden and refine the sequences of climate proxy records to enable modelling at a level of regional specificity far greater than most currently available Scottish scenarios, which are grounded in data obtained from geographically remote areas: Greenland, Baltic Sea, Urals-Siberia. Such regional-level models invite discussion of the lived experience of peasant populations who strove to subsist in a regime of shifting 'bad year economics' (*Halstead – O'Shea 2004*).

Models, however, are only as good as the proxies upon which they are constructed. Until recently, most 'native' Scottish sources of proxy data were derived from the Atlantic-facing western margins of the country and lacked the fine-grained resolution necessary for socio-economic impact modelling of even those regions let alone for areas further east. Scotland's topography determines a marked east-west differentiation in temperature and rainfall, with higher rainfall in the mountainous, Atlantic-facing west, an appreciable rain-shadow in the east, oceanic amelioration of winter temperatures in the west and colder winter temperatures further east. Comparison with modern, instrumentally recorded data for eastern and western mainland weather, however, lends significant weight to models for medieval central and eastern Highland conditions based on long sequences of north-western mainland and Atlantic west-coast proxy data.

What are the sources of this proxy data? Some, which elsewhere have enabled construction of climate models extending back over two millennia – particularly the annual summer growth-ring sequences from temperature and moisture sensitive tree-species – are currently unavailable for most of Scotland. The ecology of Scotland's native woodlands, historic woodland-management practices, and poor architectural or archaeological survival of structural timbers from known native sources, has until recently limited the value of tree-ring evidence as a long-sequence climate proxy for summer conditions (for overview see *Mills – Crone 2012*). This position contrasts sharply with the availability of such data in northern and western Ireland. Oak, the main species from which the long growth-ring sequences used to calibrate chronologies in Ireland have been obtained, has been subject in Scotland to such intensive management that few living trees older than ca 550 years remain. A handful of older veterans are present in managed lowland park landscapes, but their geographical isolation from the living populations and preserved timbers upon which English and Irish tree-ring sequences have been established has restricted their effective use. Recent discovery of medieval oak timbers – for example in the refectory roof of Paisley Abbey (*Canmore 2020*) and in the submerged oak structure in Hunterston Sands (*History Scotland 2014*), both in the south-western lowlands – offers the prospect of a linkage of surviving living trees in the Cadzow and Loch Lomond oakwoods into northern Irish sequences. Too little survives, however, to enable the kind of Summer rainfall and temperature models constructed for Ireland to be advanced with confidence from the currently available Scottish evidence.

Pine, which has a broader distribution than oak and which was used to a greater extent as a constructional timber throughout upland Highland areas, has been advanced as a potential proxy data source with a wider Scottish range than oak (*Rydval et al. 2017*; *Mills – Crone 2012; Wilson et al. 2011*; *Mills 2008*). Although there are no living Scottish pines older than around 225 years, a focus on surviving structural timbers and on wood recovered from water-logged or peat-preserved contexts has allowed a long dendrochronological sequence to be constructed for the mountainous northern Cairngorm region in north-eastern Scotland, at present spanning some eight centuries. C14 dating and calibration against trends evident in the oak sequences, speleothems (discussed below) and other climate proxies show similar responses affecting the pinewoods, most noticeably at present the impact of atmospheric cooling and increased precipitation in the 14th century.

The palaeohydrological records of peat profiles and speleothems from the Tralligil basin in the north-western mainland offer a further important proxy data source (*Charman et al. 2001*). Used as a measure for winter precipitation, these data have revealed synchronous

trends with Greenlandic ice-core data across the last two millennia. In respect of medieval climate change, they show a marked increase in rain and/or snowfall peaking in the late 14th century, around 570 years BP. There is still debate over the fine-grained accuracy of this data but that is balanced by general acceptance that these palaeohydrological records provide an annual resolution climate reconstruction of local rainfall and regional winter atmospheric pressure system patterns in the North Atlantic Oscillation [NAO]. Together with our understanding of shifts in oceanic water circulation, in this context the Atlantic Meridional Overturning Current [AMOC], this NAO-related data enables construction of generalised models for winter weather across parts of northern Highland Scotland in the late medieval period. Temperature data is more contested but using instrument-recorded modern data for similar NAO patterns it is likely that increasing precipitation was accompanied by decreasing winter temperatures across the 14th and 15th centuries in north-west Highland Scotland, which would accord with historical records of extreme winters, delayed springs and cooler summers with higher precipitation. Accompanying that decline came a shortened growing season that was accentuated by altitude, affecting traditional short-range transhumance regimes.

When taken in combination with research into deep-water renewal in fjord-like west coast lochs like Loch Etive and Loch Sunart, where changes in biotic and isotope indicators for temperature and relative salinity have been used as palaeoclimate proxies, the palaeohydrological evidence becomes more promising yet (*Cage – Austin 2010*; *Stott et al. 2010*). Increased or lowered salinity levels in these almost landlocked inlets are indicative of drought (high salinity) or high precipitation (low salinity) reflective of variation in freshwater run-off from the surrounding land into the lochs. Like the palaeohydrological records, the principal driver for these changes is understood to be the NAO, working in conjunction with the AMOC. At Loch Sunart, a marked lowering of bottom-water temperatures from an MCA high occurred after the middle of the 13th century, recovered in the first decade of the 14th century before falling through the 1310s, significant annual fluctuations through to the 1350s when a profound drop was recorded, with a recovery into the first decades of the 15th century ending in a slide to the lowest temperatures recorded since the pre-MCA early 10th century. This record from the south-western Highland zone correlates closely with the palaeohydrological record from the north-west zone, pointing generally to rising levels of precipitation from the 1250s, interspersed with brief episodes of prolonged drought, coupled with a downward trend in temperatures remarkable for extended periods of extreme coldness in the late 1400s. In summary, the weakening of the NAO after the highs of the MCA brought

a general shift into colder, wetter and – bringing in a third proxy record in the form of optically stimulated luminescence (OSL) dates for major episodes of dune deflation and sand-blow in the Outer Hebrides (*Gilbertson et al. 1999*; *Dawson et al. 2011*) – stormier winters and generally cooler and wetter summers.

<h2>Human responses: practice and legislation

Together, these climate proxies chart long-term shifts in the weather systems reaching Scotland from the North Atlantic. It is unlikely that such shifts had no cumulative impact on resource exploitation regimes founded on traditional environmental knowledge that had been built up across the three centuries of the MCA. For communities in Scotland's Southern Upland and Highland zones, increased rainfall and cooler temperatures affected everything from fuel supply – dominated in such regions by peat consumption – through to meat and milk yields from cattle and yield ratios of cereal crops, although this may have been offset in part by an increased reliance on more wet- and cold-tolerant oat species (*Tipping 1998*). A survey of the renders in kind from royal estates recorded in the surviving accounts of the Scottish exchequer reveals a progressive shift towards oat-production through the 14th and 15th centuries, continuing into the 16th century (*Stuart et al. 1878-1908*), paralleled by increasingly frequent legislative efforts to manage planting and land-management practices, and the trade in victuals (e.g. *Brown et al. 2007-2020*, 1370/2/8, 1401/2/15, 1426/39, 1452/5, 1454/3, 1458/3/28-9, 1486/3/2, 1540/12/70). Here, Scotland's royal administration and parliament were seeking to address the perceived causes of declining productivity, food shortages, and the concomitant decline in revenue yields through punitive legislative measures. They viewed the recurrent supply crises purely in human terms as the consequence of poor practice and solvable through human action impelled by legal enforcement. Scotland's 15th-century legislators, however, were seeking to address the results of poorer growing conditions through instructing landowners and their tenants simply to plant and grow higher volumes of grain crops or increase their livestock numbers.

It is in these legislative measures and in the records of efforts by landowners to adopt them, that we can see best the interplay of human and environmental factors and detect on the ground the results of such endeavours. The financial accounts of the monastic landlords of the Coupar Angus abbey estates in upper Glen Isla, for example, detail efforts to regulate carrying capacity on seasonal upland pasture and increase the planting of woodland, management of scrub species and sowing levels on the arable land there (*e.g. Rogers 1880*, 141-142, 261-262). They were, however, struggling in an age of reduced biomass production,

with more days per annum failing to reach the critical 6˚C temperature threshold for grass-growth. This reduced grass-growth affected carrying capacities of summer and winter grazing land and entailed either reductions in livestock-to-acreage ratios (known as *soums*) or increases in the extent of grazing assigned to a community (*Ross 2006*). Where such changes were not negotiated locally, conflict over control of, or access to, resources proliferated, escalated and intensified. Whilst recognising that we lack at present much data from the eastern watershed zones, extrapolation from instrumentally-recorded atmospheric and precipitation records in lowland and especially east coast locations suggests that even with the buffering effect of the mountains eastern agricultural regimes were confronted with only moderately ameliorated challenges and their seasonal upland grazing resources suffered the same impacts as were experienced further north and west. For perennial settlement, the same temperature threshold and increased rainfall affected production of less cold- and wet-tolerant wheat, again potentially offset by a move to oat-cultivation, and may have been in part responsible for the altitudinal drop in cultivation evident in the abandoned field systems in the upland districts of southern and south-eastern Scotland. Estuarine lands brought into agriculture during the peak of the MCA were abandoned in the face of repeated marine transgression, as evidenced from the districts around the head of the Solway Firth in the south-west and the carselands of the Forth estuary in the east. Lowland districts from Ayr to Sanday and Westray in Orkney, Eldbotle in Lothian, or Forvie in Aberdeenshire experienced repeated episodes of dune deflation and sand-blow, which either inundated or stripped away the cultivated ground (*Oram 2014b*, 205). In each case, this arose from a disastrous interplay of cultivation of calcareous shell-sand zones, stripping of turves from the dune systems for anthrosol formation in garden plots, animal action, and strengthening of westerly winds attendant on the negative NAO (*Oram 2014b*, 206-211). Human and natural agency delivered a veritable ‘perfect storm’.

<h2>Conclusions

When expressed in direct human experiential terms rather than as a catalogue of symptoms of environmental stress, the impact of long-term climate change on the seasonal upland regimes upon which much of Highland Scotland’s population subsisted was devastating. Even against the backdrop of plague mortality and still falling population levels from the middle of the 14th century, the continued downward climatic trend meant that little slack was created in a system that had been poised on a subsistence knife-edge since before the end of the MCA. It is in this context that we should see the record of increased resort to legitimate and

illegitimate violence in later medieval Scotland. This phenomenon is characterised or, indeed, caricatured by the rise of the militarised Highland kindreds with their culture of conspicuous consumption, predation, ritualised raiding and mercenary service. It is evident also in the political factionalism of the non-Highland nobility of the 15th century, much of which had competition for resources at its root (*Oram 2014c*; *Oram – Adderley 2008; Oram – Adderley 2010*). Warfare and political instability at national level exacerbated the difficulties but these were more symptoms of wider socio-economic dislocation than a cause. In short, people were moving into new relationships of dependency and power, often expressing those relationships in the language of continuity from a near-mythical Golden Age as they negotiated their way through an era of profound environmental transformation.

And this is perhaps the greatest significance in closer examination of the Scottish experience, the fact that Scotland as a polity endured despite the multiplicity of insults to its socio-economic metabolism. For very understandable methodological and opportunistic reasons, much of the palaeoenvironmental and environmental historical research effort of the last three decades has focused on Greenland and Iceland as laboratories for how complex societies were affected by catastrophic climate change. The historical experience of those lands, it is suggested, provide insight on likely consequences of current climate change in terms of both environmental and societal impacts. Indeed, they do; but those societies failed or survived only through reduction to dependency at the margins of an external provider, Norway. Medieval Scotland, however, proved to be resilient but with resilience won at significant cost, including successive episodes of profound social reconfiguration in which social dislocation and violence played powerful roles. Yes, Scotland had access to a broader suite of resources and, in comparison to the extremes of climatic deterioration experienced in 14th- and 15th-century Greenland, suffered far less dramatic decline in climate and weather conditions, but what differentiates it from the northern Atlantic territories is the record that survives for responses to the palpably negative changes which it endured. At present, however, our understanding of the motors driving change and how those changes were experienced is limited still to headline statements and mainly related to locations on the geographical margins of the medieval kingdom. This skewed national picture has the positive value of elucidating the mechanisms for the transformations evident in the archaeological and palaeoenvironmental record of regions otherwise lacking in the documentary sources which elsewhere drive the change narrative. Any epiphany in understanding of the social, economic, cultural and, probably, political reconfigurations occasioned in medieval Scotland by the distressed condition of its rural regimes and especially their seasonal upland constituents,

however, is yet to be expressed in human rather than more abstract environmental terms. The data exists; we now require the awakening of the imagination of most Scottish archaeologists and historians to interpret its meaning and translate it into terms accessible to non-specialist audiences.

<h2>References:

History Scotland 2014:
Early medieval coastal site discovered at Firth of Clyde - Scottish Archaeology. History Scotland. Published online at https://www.historyscotland.com/history/early-medieval-coastal-site-discovered-at-firth-of-clyde-scottish/ (accessed 22. 01. 2020).

Atkinson, J. 2016:
Ben Lawers: an archaeological landscape in time. Results from the Ben Lawers Historic Landscape Project, 1996–2005. Scottish Archaeological Internet Report 62. Published online at https://archaeologydataservice.ac.uk/library/browse/issue.xhtml?recordId=1137495&recordType=MonographSeries (accessed 16. 01. 2020).

Beament, E. 2020:
Climate scientists confirm 2010s was hottest decade recorded, in: The Independent Online, 15 January 2020. Published online at http://independent.co.uk/environment/climate-crisis-decade-warmest-science-weather-el-nino-a9284746.html (accessed 16. 01. 2020).

Brown, K. – MacIntosh, G. H. – Mann, A. J. – Ritchie, P. E. – Tanner, R. J. 2007-2020:
The Records of the Parliaments of Scotland to 1707. University of St Andrews. St Andrews. Published online at http://www.rps.ac.uk.

Brown, T. – Crane, S. – O'Sullivan, D. – Walsh, K. – Young, R. 1998:
Marginality, multiple estates and environmental change: the case of Lindisfarne, in: Mills, C. M. – Coles, G. (eds.), Life on the edge. Human settlement and marginality. Oxbow Monograph 100. Oxbow Books. Oxford, 139-148.

Cage, A. G. – Austin, W. E. N. 2010:

Marine climate variability during the last millennium: The Loch Sunart record, Scotland, UK, Quaternary Science Reviews 29, 1633-1647.

Canmore 2020:
Canmore, Paisley, Place of Paisley. Published online at https://canmore.org.uk/site/43140/paisley-place-of-paisley (accessed 22. 01. 2020).

Charman, D. J. – Caseldine, C. – Baker, A. – Gearey, B. – Hatton, J. – Proctor, C. 2001:
Paleohydrological records from peat profiles and speleothems in Sutherland, Northwest Scotland, Quaternary Research 55 (2), 223-234.

Dawson, S. – Dawson, A. G. – Jordan, A. T. 2011:
North Atlantic climate change and Late Holocene windstorm activity in the Outer Hebrides, Scotland, in: Griffiths, D. and Ashmore, P. (eds.), Aeolian Archaeology: the Archaeology of sand landscapes in Scotland, Scottish Archaeological Internet Report 48. Published online at http://sair.org.uk/sair48 (accessed 16. 01. 2020).

Dixon, P. 2007:
Hunting, summer grazing and settlement: competing land use in the uplands of Scotland, Ruralia 7, 27-46.

Gilbertson, D. D. – Gilbertson, D. – Schwenninger, J. – Kemp, R. – Rhodes, E. 1999:
Sand-drift and soil formation along an exposed North Atlantic coastline: 14,000 years of diverse geomorphological climatic and human impacts, Journal of Archaeological Science 26, 439-469.

Halstead, P. – O'Shea, J. (eds.) 2004:
Bad year economics: cultural responses to risk and uncertainty. New directions in Archaeology. New edition. Cambridge University Press. Cambridge.

Mills, C. 2008:
Historic pine and dendrochronology in Scotland, Scottish Woodland History Discussion Group: Notes XIII, 9-14.

Mills, C. M. – Crone, A. 2012:
Dendrochronological evidence for Scotland's native timber resources over the last 1000 years, Scottish Forestry 64(1), 18-33.

Oram, R. D. 2014a:
'The worst disaster suffered by the people of Scotland in recorded history': climate change, dearth and pathogens in the long 14th century, Proceedings of the Society of Antiquaries of Scotland 144, 223-244.

Oram, R. D. 2014b:
From 'Golden Age' to depression: land, lordship and environmental change in the medieval Earldom of Orkney, in: Gulløv, H. C. (ed.), *Northern Worlds – landscapes, interactions and dynamics*. Studies in Archaeology & History Vol. 22. Publications from the National Museum. Copenhagen, 203-214.

Oram, R. D. 2014c:
Between a rock and a hard place: climate, weather and the rise of the Lordship of the Isles, in: Oram, R. (ed.), The Lordship of the Isles. Brill. Leiden, 40-61.

Oram, R. D. – Adderley, P. 2008:
Lordship and environmental change in central Highland Scotland c.1300 to c.1450, Journal of the North Atlantic 1, 74-84.

Oram, R. – Adderley, P. 2010:
Lordship, land and environmental change in West Highland and Hebridean Scotland c.1300-c.1450, in: Cavaciocchi, S. (ed.), Economic and biological interactions in pre-Industrial Europe from the 13th to the 18th centuries. University of Florence Press. Florence, 257-268.

Rogers, C. (ed.) 1880:
Rental Book of the Cistercian Abbey of Cupar-Angus. Volume II. Grampian Club. London.

Ross, A. 2006:
Scottish environmental history and the (mis)use of Soums', Agricultural History Review 54, 213–138.

Ross, A. 2015:
Land assessment and lordship in medieval Northern Scotland. The Medieval Countryside 14. Brepols. Turnhout.

Rydval, M. – Loader, N. J. – Gunnarson, B. E. – Druckenbrod, D. L. – Linderholm, H. W. – Moreton, S. G. – Wood, C. V. – Wilson, R. 2017:
Reconstructing 800 years of summer temperatures in Scotland from tree rings, Climate Dynamics 49, 2951-2974.

Slavin, P. 2010:
The Fifth Rider of the Apocalypse: the Great Cattle Plague in England and Wales and its economic consequences, in: Cavaciocchi, S. (ed.), Economic and biological interactions in pre-Industrial Europe from the 13th to the 18th centuries. Florence University Press. Florence, 165-179.

Slavin, P. 2019:
Experiencing Famine in Fourteenth Century Britain. Environmental Histories of the North Atlantic World 4. Brepols. Turnhout.

Stott, K. J. – Austin, W. E. N. – Sayer, M. D. J. – Weidman, C. R. – Cage, A.G. – Wilson, R.J.S. 2010:
The potential growth of *Arctica islandica* growth records to reconstruct coastal climate in north west Scotland, UK, Quaternary Science Reviews 29, 1602-1613.

Strachan, D. – Sneddon, D. – Tipping, R. 2019:
Early medieval settlement in Upland Perthshire: excavations at Lair, Glen Shee 2012-17. Archaeopress Publishing Ltd. Oxford.

Stuart, J. – Burnett, G. – McNeill, G. P. (eds.) 1878-1908
The Exchequer Rolls of Scotland, 1326-1600. 23 volumes. H. M. General Register House. Edinburgh.

Tipping, R. 1998:

Cereal cultivation on the Anglo-Scottish Border during the ‘Little Ice Age’, in: Mills, C. M. – Coles, G. (eds.), Life on the Edge. Human settlement and marginality. Oxbow Monograph 100. Oxbow Books. Oxford, 1-11.

Tipping, R. 2004:
Palaeoecology and political history; evaluating driving forces in historic landscape change in southern Scotland, in: Whyte, I. D. – Winchester, A. J. L. (eds.), Society, landscape and environment in Upland Britain. Society for Landscape Studies supplementary series 2. The Society for Landscape Studies, 11-20.

Wilson, R. – Loader, N. J. – Rydval, M. – Patton, H. – Frith, A. – Mills, C. M. – Crone, A. – Edwards, C. – Larsson, L. – Gunnarson, B. E. 2011:
Reconstructing Holocene climate from tree rings: the potential for a long chronology from the Scottish Highlands, The Holocene 22(1), 3-11.